



## **In-situ ETEM Study of Nucleation and Growth Termination Mechanism of Single-Wall Carbon Nanotubes**

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### In-situ ETEM Study of Nucleation and Growth Termination Mechanism of Single-Wall Carbon Nanotubes

**101**

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#### Abstract

The promising application of single-wall carbon nanotubes (SWCNTs) in nano-electronics, strongly depends on the controllability of their atomic structures. Much effort has been devoted to designing novel catalysts and optimizing synthesis parameters. In this respect, it is critical to reveal the roles of catalysts and carbon source on the SWCNT structures, which requires the in-depth understanding the growth mechanism of SWCNTs, especially at the initial and final growth stages. However, the detailed microscopic secrets of SWCNT nucleation and growth cessation are still lacking. Here we present direct experimental evidence on the nucleation [1] and termination [2] of SWCNTs by using environmental transmission electron microscopy (ETEM) [3]. We demonstrate the long-lasting activity of catalysts based on the fact of multiple nucleation from the same particle. Insufficient active carbon species and a certain amount of stresses exerted at the tube-catalyst interface are proposed as the main cessation reasons in this study. Therefore, special attention should be paid to the stability of carbon supplies and the growth environments in future studies. Additionally, crystalline metal catalysts with low carbon solubility were also comparably studied, further confirming the above conclusion. All of these nucleation and termination mechanisms support many phenomena of CNT growth and provide valuable insights which enables further control over the structure of SWCNTs individually or on a macroscale.

#### Reference

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- [3] Hansen, T.W.; J.B. Wagner; Catalysts under Controlled Atmospheres in the Transmission Electron Microscope. *ACS Catal.*, 4, 1673, 2014